Hypotheses, Laws, and Theories– oh My!

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What is a scientific law? How does it differ from a hypothesis or a theory? How does a theory become a law? These are all great questions that you really need to be able to answer.

A scientific hypothesis is not an 'educated guess". If a student is asked, "What will happen if I blow on this lit candle?" and the answer expected and provided is "It will go out.", then the student has provided an answer if they have had previous experience or a prediction if they have not, but not an hypothesis. If the student is prompted to go further and explain WHY they think the candle will go out, then the student is providing a hypothesis. He might answer "The candle will go out, because when you blow on it, it gets colder and it's not hot enough for the fire to burn". This is a hypothesis because it provides a testable explanation. These two words are key. The hypothesis explains why the behavior occurs – the fire goes out because it gets too cold, and the explanation is one that can be tested. You could put the burning candle outside on a cold winter day and see if it continues to burn. If it does, then you could conclude the hypothesis is not correct. A hypothesis is an idea of how something works, or an explanation based on the evidence available. It is a statement limited to a specific situation and must be testable. In other words, it should be something that could be proven wrong. A hypothesis is much more than a predicted outcome or an educated guess.

A scientific law is a statement of fact that is believed to be always true, but offers no explanation. The law of inertia is a wonderful example. It is understood that objects at rest will stay at rest unless a force causes them to move. Scientists do not have an explanation for WHY objects cannot begin moving from a state of rest without a force acting on them, but such a thing has never been observed and we believe it to be universally true. Kepler's laws of planetary motion fit this description well when they were initially stated. In the early 1600's we did not understand the Sun and planets were exerting forces on each other through gravitation. Kepler put together decades of data and found for the six known planets, all of them behaved in manners described by his three statements. His laws offer no explanation for WHY the planets behave this way, thus they are planetary laws. Newton's Universal Law of Gravitation fits this description as well. It does not tell us HOW two different masses exert forces on each other, it simply describes it and names it. The question "How does a theory become a law?" is a trick question! The answer is – it cannot!! Scientific theories EXPLAIN things, laws state things.

A theory in science provides a big picture understanding and view that helps to explain many different phenomena. For example, the atomic theory says that matter is made of discrete units of matter that maintain their 'identity' through physical and chemical change. This atomic theory is very useful in understanding chemical reactions and much more. Copernicus' heliocentric theory is a wonderful example. His theory attempted to explain the motion of the planets by placing the Sun in the center instead of the Earth and having the planets make nice orderly circular orbits around the Sun. This was far simpler than the complicated motions some of the planets required in order to match observation based on an Earth centered model. The heliocentric theory is not in question because it is a theory. The heliocentric theory can certainly be considered a fact. All scientists and everyone I've ever met, accept the heliocentric theory even if they can't quite recall its name. It is a theory because it explains the motions of the planets, Moon, and Sun as observed from Earth. It is a theory because it pulls together many different observations and concepts together in a unifying explanation.

Therefore, in science, the Theory of Evolution is not less certain than the Law of Universal Gravitation. They do very different jobs. The theory of evolution EXPLAINS HOW speciation occurs through natural selection and Newton's law of universal gravitation states what we observe without explanation. The heliocentric theory, the law of inertia, the theory of evolution and the Universal law of Gravitation are all facts we can build on. These facts may need small adjustments in their details as we uncover and discover new things. However, these are solid foundations from which we can launch new hypothesis in order to explain the world we live in.

We are still in search of a theory of gravitation, and no amount of testing will ever turn the heliocentric theory or the theory of evolution into a law. So, let's abandon "educated guesses" as a definition of hypotheses and let us work together to provide consistent on the use and meaning of these words in a scientific setting.